The City of Edgewood is in the process of reviewing and revising their Critical Area Ordinance (CAO) which specifies standards for development in and around critical areas. Associated Earth Sciences, Inc. (AESI) is assisting Environmental Science Associates (ESA) in their review and revision of the critical area codes. Specifically, our scope of work is limited to a review of the portions of the code addressing development within geologic hazard areas, including the following chapters of the Edgewood Municipal Code (EMC):

- Chapter 14.60 Volcanic Hazard Areas
- Chapter 14.80 Landslide Hazard Areas
- Chapter 14.90 Seismic (Earthquake) Hazard Areas
- Chapter 14.110 Erosion Hazard Areas

Under Washington’s Growth Management Act (GMA), and the Revised Code of Washington (RCW) 36.70A, protection of environmentally critical areas must take into account Best Available Science (BAS). This memo provides a summary of the BAS as it relates to the geologic hazard code. The suggested code revisions are intended to allow use of BAS for protection of critical areas, reduce the risk of damage to property by geologic hazards while avoiding excessively conservative restrictions on land use in those areas where mitigation of geologic hazards can reasonably be achieved. We have also attempted to make the code more “user friendly” by eliminating portions of the existing code that are not applicable to conditions found in the city of Edgewood, providing consistency in the use of terms, simplification of reporting requirements, and improved hazard mapping resources.

The following is a discussion of the four geologic hazard categories.
VOLCANIC HAZARDS

Volcanic Hazard Mapping

The U.S. Geological Survey (USGS) has developed mapping of volcanic hazard categories and time travel zones for Pierce County, including the City of Edgewood (USGS, 1995). This mapping represents BAS for volcanic hazards in the city and is recommended for use in identifying those areas of the city where restrictions to bonus densities, essential facilities, hazardous facilities, or special occupancy structures apply.

LANDSLIDE HAZARDS

Although landslides are often associated with steep slopes, other factors such as geology, land use, grading, extreme weather events and other climatic factors can contribute to landslide hazard risk over a wide range of topographic conditions. In the Puget Lowland, topographic and geologic conditions vary greatly over a relatively small area and it is therefore important to understand the conditions and processes associated with landslide hazard risk. For this reason, critical area codes typically include requirements for geologic hazard studies by qualified geotechnical professionals to evaluate hazard risk and mitigation options in areas of suspected risk. The landslide hazard code is designed to provide screening criteria to identify areas of potential risk, and to establish minimum standards for further geotechnical study and development standards in these areas.

The following is a discussion of technological advancements in landslide hazard studies, development trends, area specific conditions, and recommended changes to the Edgewood landslide hazard code.

Identification of Existing Landslide Features

A relatively recent technological advance that has improved the ability to identify existing landslide features is LiDAR-based imagery. High quality, LiDAR-based imagery has become increasingly available throughout Western Washington and is currently available for the entire Puget Lowland (Puget Sound LiDAR Consortium). LiDAR (Light Detection and Ranging), uses airborne scanning lasers generating topographic surveys of the ground and top of vegetation, referred to as first returns and last returns. These laser transmitters fire thousands of pulses per second. Typically the data is gathered in winter when leaves are off. Data is filtered by travel time of laser pulses to determine ground surface versus top of vegetation or built environment (Harding, 2000). The bare earth data is particularly useful in areas such as Western Washington where surface features are typically obscured by heavy vegetation. For this reason, LiDAR imagery has been found to be a useful tool in identifying landslide features not readily recognizable by conventional aerial photography or ground reconnaissance (Baum et al., 2007; McKenna et al., 2008).

Development in Landslide Hazard Areas

The rapid population growth in the Puget Lowland in recent decades has resulted in widespread development, decreased availability of land, and increasing development costs. In response to this trend, property owners seek to maximize use of the developable portions of their land within the constraints of the local critical area codes. In response to land development pressures and the need to protect the environment and public safety many municipalities require site-specific studies by qualified professionals for proposed

Project No: 170237E001
developments in geologic hazard areas to evaluate site conditions, identify potential impacts and risks, and provide options for suitable mitigation of hazards. These site-specific studies qualify as BAS based on the criteria presented in Chapter 365-195-905 of the Washington Administrative Code (WAC) by providing relevant data to evaluate landslide hazard risks and recommendations for mitigation of those risks. Municipalities lacking in-house expertise to evaluate the adequacy of these site-specific critical area studies have the option of requiring a third party geotechnical peer review. This review process and code-specified report requirements encourages BAS.

Area-Specific Conditions

The city of Edgewood is located on a plateau bounded to the east by the White River valley and to the south and southwest by the Puyallup River valley. Review of the draft geologic map of the Puyallup 7.5 minute quadrangle by GeoMapNW (2004) and the Geologic Map of the Poverty Bay 7.5 Minute Quadrangle, King and Pierce Counties, Washington by Booth et al. (2004) indicates that the plateau is primarily underlain by glacially derived or glacially overridden sediments. Steep slopes occur along the flanks of the plateau and in several drainage ravines, such as Simons Creek and several other unnamed creeks, that extend from the plateau down into the adjacent river valleys. Areas of moderately inclined slopes also occur in some areas along the flanks of the plateau, in the drainage ravines incised into the plateau, and in isolated locations on the plateau surface. Landslide Hazard Areas or potential Landslide Hazard Areas are limited to these moderately to steeply sloping areas. Post-glacial (Holocene) alluvial sediments are mapped in several locations along the lower flanks of the plateau and in the portions of the city that extend out into the Puyallup and White River valleys.

Review of Existing Regulations

Based on review of geologic hazard codes for cities and counties in the Puget Lowland, including the City of Edgewood, the codes are generally crafted to mitigate landslide hazards by establishing buffers and/or building setbacks from high risk areas, or by restricting these areas to limited activities or uses. Complexities in the codes arise in describing details, such as exemptions, variances, permitted alterations, performance standards, buffer/building setbacks, or minimum standards for geotechnical studies. In some cases, key terms, requirements, or references in the code are poorly defined, not applicable to site conditions, or are inconsistent with standards of practice or BAS, which can lead to disputes. The following is a description of suggested changes, organized by category within the code. Some of the suggested changes presented below are discussed in general terms and may not refer to specific code citations. For a more detailed description of the suggested changes, please refer to the Gap Analysis Matrix.

Definitions

Section 14.80.020 of the EMC provides a list of landslide hazard indicators or indicators of potential landslide hazards. The suggested changes to the existing code are intended to provide clarification, eliminate indicators not applicable to the City of Edgewood, are not necessarily indicative of past landsliding or increased risk of future landsliding, or are not consistent with BAS. A summary of the proposed changes is provided below.

- We recommend eliminating EMC 14.80.020(A)(2) which refers to areas of active bluff retreat. We recommend removal of this section because in the Puget Sound region, the term “bluff” is normally used in reference to steep slopes along marine shorelines, which are not present in the City.
We recommend revising EMC 14.80.020(A)(3) to refer to “Areas with all of the following characteristics.” The addition of the words “all of” clarifies that all of the characteristics listed in this section must be present to be considered a Landslide Hazard Area.

We recommend revising EMC 14.80.020(A)(3)(a) to include slopes steeper than 15 percent rather than 20 percent. Although landslides in the Puget Lowland rarely occur on slopes flatter than 15 percent, landslides have been known to occur on slopes flatter than 20 percent (Laprade, 1989). Reducing the minimum inclination threshold to 15 percent is also consistent with codes in other municipalities in the surrounding area (e.g., Sumner and Bonney Lake).

We recommend eliminating EMC 14.80.020(A)(4) which refers to structural features typically reserved for evaluation of landslide hazards in bedrock. Review of the previously referenced geologic maps indicate that there are no bedrock exposures in the City of Edgewood.

We recommend that EMC 14.80.020(A)(5) and EMC 14.80.020(A)(6) be combined into a single code section that eliminates reference to “past slope failure” without regard to age or to specific characteristics of historical landslide areas. We recommend that the revised section instead refer to “areas exhibiting geomorphological features indicative of historical slope movement during the past 10,000 years.” This provides further clarity and eliminates inclusion of older landslide deposits which formed at a time when subsurface and topographic conditions were different from the existing conditions.

We recommend eliminating EMC 14.80.020(A)(7) which requires that areas with structures that exhibit structural damage be defined as Landslide Hazard Areas. We recommend that this section be eliminated because structural damage to buildings is not unique to areas of landslide activity.

We recommend eliminating EMC 14.80.020(A)(8) which requires that areas with distorted tree trunks be defined as Landslide Hazard Areas. We recommend that this section be eliminated because tree trunk distortion is not unique to areas of landslide activity.

We recommend eliminating EMC 14.80.020(A)(9) which requires that areas with soft or liquefiable soils be defined as Landslide Hazard Areas. We recommend that this section be eliminated because the presence of soft or liquefiable soils (without consideration of other factors, such as slope inclination) is not typically indicative of high landslide risk. In addition, areas underlain by liquefiable soils are addressed in the Seismic Hazards section of the Edgewood code (Chapter 14.90).

We recommend eliminating EMC 14.80.020(A)(10) which refers to certain areas that have been subjected to gully or other surface erosion. These features are characteristic of erosion hazards and are addressed in Chapter 14.110 of the code.

We recommend eliminating EMC 14.80.020(A)(11) which refers to areas of seeps or springs on or adjacent to slopes. We recommend eliminating this section because these characteristics are already addressed in EMC 14.80.020(A)(3).

We recommend modifying EMC 14.80.020(A)(12), which refers to slopes of 40 percent or steeper over a height of at least 15 feet. Specifically, we recommend the following modifications:
1. We recommend that the minimum vertical relief be decreased from 15 feet to 10 feet. This modification is recommended because our experience has indicated that landsliding can occur on slopes with heights less than 15 feet.

2. We recommend that the exemption for manmade slopes created under the design and inspection of a geotechnical professional be extended to all manmade slopes provided that it can be demonstrated by a geotechnical professional that such an exemption does not result in increased risk of landsliding or property damage. Many legally graded slopes were either created at a time when the services of a geotechnical professional were not commonly required or predate the time over which engineering records are commonly available. Because legally graded slopes are numerous (such as those associated with road construction) exemption of such slopes avoids unnecessarily onerous restrictions on property use.

3. We recommend that the reference to EMC 14.80.060, Appendix D be eliminated as this section of code does not exist.

- We recommend replacement of the “Critical Areas Atlas – Landslide Hazard Areas Map” in EMC 14.80.020(B) with the updated “Geologically Hazardous Areas” map. We understand that the updated map is based, in part, on LiDAR data and the most recent volcanic hazard data available from the USGS, and therefore represents BAS. All references to the old Critical Areas Atlas should be replaced with a reference to the updated map throughout the geologic hazard code.

- All references in the code to the Washington Department of Ecology Coastal Zone Atlas (CZA) should be removed. The CZA addresses marine shoreline areas in Washington. No marine shorelines are located in the City of Edgewood.

- We recommend that the term “engineering geologist” be replaced with the term “geotechnical professional.” These terms are used somewhat interchangeably in the code, although the term “geotechnical professional” is also used in reference to geotechnical engineers. In order to be consistent, we recommend use of the term “geotechnical professional” over engineering geologist to avoid confusion.

**Geological Assessments**

EMC 14.80.030 includes a description of the requirements for Landslide Hazard Area review procedures, including geological assessments. In consistency with BAS, we recommend that the use of LiDAR-based mapping be incorporated into the list of recommended or required research sources to be reviewed as part of geological assessments. Specific sections of the code affected by this recommendation include EMC 14.80.030(B)(2) and EMC 14.80.030(B)(5).

The existing code describes three types of geological assessment reports. In order of increasing complexity, these include Geotechnical Letter, Geotechnical Verification, and Geotechnical Report. The code specifies the conditions in which each of these three types of reports are required. In general, the complexity of the required report is based on the proximity of the site (or project area within a site) to a potential or known Landslide Hazard Area based on review of the City’s landslide hazard mapping or other source documents.
We recommend that the Geotechnical Letter be removed from the code and replaced with the Geotechnical Verification as the minimum reporting standard. In our opinion, the Geotechnical Verification presents a reasonable minimum standard of reporting and elimination of the Geotechnical Letter provides some simplification of the code.

**Development Standards**

EMC 14.80.040(B) specifies minimum standards for regulated activities within 300 feet of a Landslide Hazard Area. Section 14.80.040(B)(4) of the code states that “The proposed development shall not decrease the factor of safety for landslide occurrence below the limits of 1.5 for static conditions or 1.2 for dynamic conditions.” Until relatively recently, it was unusual for minimum factors of safety to be specified within geologic hazard codes in the Puget Sound region. Prior to that time, minimum acceptable factors of safety were typically based on “standard of practice” values, typically 1.5 for static conditions and 1.1 for dynamic conditions. Within the past several years, incorporation of minimum factors of safety for slopes into geologic hazard codes has become increasingly more common. Although this trend is likely driven primarily by the value such analyses provide to the assessment of landslide hazard risk and the availability of user friendly computer software, recent high-profile landslide events, such as the 2014 Oso landslide, have created a heightened awareness of landslide hazards. During the past several years, design accelerations have also increased dramatically from approximately 0.15g to up to 0.3g in some areas. In our opinion, revision of the code to include minimum factors of safety of 1.5 for static conditions and 1.1 for dynamic conditions provides a reasonable level of conservatism in line with the common standard of practice and other area jurisdictions, such as Bonney Lake and Snohomish County.

EMC 14.80.050 specifies minimum buffer widths around Landslide Hazard Areas. Specifically, the existing codes states that the minimum buffer shall be the greater amount of the following distances:

1. 50 feet from all edges of the Landslide Hazard Area;
2. A distance of one-third the height of the slope at the top of a Landslide Hazard Area;
3. A distance of one-half the height of the slope at the bottom of a Landslide Hazard Area; or,
4. The minimum distance from the edges of the Landslide Hazard Area recommended by the geotechnical professional.

In our opinion, the existing code should be revised to allow reduction of buffer widths below the default values listed above in items 1-3, if it can be demonstrated by the geotechnical professional through BAS that a reduced buffer will not result in an increased risk of landsliding or landslide-related property damage.

**Reporting**

Minimum reporting requirements are specified in Section 14.80.060 of the code. The following revisions are intended to revise the reporting requirements to be consistent with typical standard of practice and BAS as discussed below.

- We recommend that the requirement for the first page of the document to be titled “Landslide Hazard Geotechnical Verification” or “Landslide Hazard Geotechnical Report” be removed. Typically the contents of either of these documents would be conducted as part of an overall geotechnical engineering report that would address other geotechnical aspects of the project, such as design
values and other geologic hazards. Therefore, the report title as required under the existing code would not be appropriate given the scope of the report content.

- The geotechnical verification or report summary should include a discussion of the observations, subsurface conditions, and documents reviewed to verify compliance with the minimum reporting requirements.

- We recommend removing the requirement for a statement of qualification paragraph as currently specified in Appendix B (A)(9) of the EMC. Reporting requirements already specify that the document must be signed and stamped by a geotechnical professional, which would already be sufficient to demonstrate compliance with the minimum qualification requirements. In addition, the latter part of the statement of qualification consists of a statement verifying that the scope of the investigation is sufficient. It is the intent of any study to meet this standard and if the scope of the investigation is not met, either by incompetency of oversight, the City has the right to respond with review comments.

- We recommend that Appendix C (A)(9)(a) and (A)(9)(b) be removed from the code. These sections of the code specify required geotechnical exploration methods for borings and cone penetrometer tests, as well as detailed descriptions of required exploration log formats. In our opinion, boring log scale, content, sampling methods, and soil descriptions should be at the discretion of the geotechnical professional based on their professional opinion and project specific needs. Boring log scales and formats may vary depending on the type and depth of exploration. Overly detailed descriptions of drilling equipment used may not be useful or appropriate, sampling intervals and methods may vary with project needs and site conditions, and soil classification/descriptions/data presentation should be at the discretion of the licensed geotechnical professional based on project scope and subsurface conditions at the site.

- Appendix C (A)(10) includes a requirement for soil strength and index properties of all soil units encountered at a site to be listed in the report, along with justification for their use. This section appears to be intended for projects where a quantitative slope stability analysis is conducted. Such an analysis is not appropriate for all projects and inclusion of this information may not be applicable. We recommend that where inclusion of this information is appropriate, the format of presentation and basis for justification of the values used be at the discretion of the geotechnical professional.

- Appendix C (A)(12) requires that all reports include a quantitative slope stability analysis. In our opinion, a quantitative slope stability analysis may not be appropriate for all projects. We recommend that the need for a quantitative slope stability analysis be conducted at the discretion of the geotechnical professional with the provision that:

1. The geotechnical professional must provide justification for not including a quantitative slope stability analysis if one is excluded; and,

2. The City’s geotechnical professional reserves the right to request a quantitative slope stability analysis based on site conditions; and,
3. If a dispute arises between the City’s geotechnical professional and the project geotechnical professional regarding the need for a quantitative slope stability analysis, the City reserves the right to require an independent, third party review to be paid for by the applicant to resolve the dispute.

- We recommend revising Appendix C (A)(13) to allow design plans and detailed geotechnical recommendations for mitigation of landslide hazards to be submitted in a document separate from the geotechnical report. Development of mitigation plans is often the result of a multi-phased effort and therefore the requirement for all information, including design plans, within a single report may not be practical.

SEISMIC HAZARDS

EMC 14.90.020 states that “Seismic Hazard Areas are areas subject to severe risk of damage as a result of earthquake-induced landsliding, seismic ground shaking, dynamic settlement, fault rupture, soil liquefaction, or flooding caused by tsunamis and seiches.” Two factors that contribute to earthquake damage are ground motion and the presence of loose, saturated soils that lose strength during seismic events.

Regional Seismic Issues

All of Western Washington is at risk of strong seismic events resulting from movement of tectonic plates in the Cascadia Subduction Zone (CSZ). Geologic studies have documented large CSZ earthquakes in the past, such as the estimated M 9.0 earthquake that struck the Pacific Northwest in January 1700 (Obermeier and Dickenson, 2000). This earthquake was centered near the Washington coast. Other potential sources of strong ground motion events in the Edgewood area include the Tacoma and Seattle Faults. The Tacoma Fault is an east-west trending fault zone that spans Puget Sound north of Tacoma. Recent studies have identified evidence of a large (approximately M 7) seismic event near the Tacoma Fault Zone approximately 1,100 years ago (Gomberg et al., 2010). The Seattle Fault, also an east-west trending fault zone, extends through Seattle, extending east in the vicinity of the I90 corridor (Johnson et al., 2004). Studies have indicated that movement along the Seattle Fault caused an earthquake with an estimated magnitude of 7.5 approximately 1,000 years ago (Brink et al., 2006). Earthquakes could also originate from movement along other crustal faults, such as the M 6.8 Nisqually Earthquake in 2001.

Area-Specific Conditions

Liquefaction

During an earthquake, subsurface soils are subjected to a series of cyclic shear stresses that vary in magnitude. Saturated, loose granular sediments subjected to these cyclic loading conditions can develop rapid increases in the pore pressures within the sediments sufficient to cause a sudden loss of strength. This rapid increase in pore water pressure can transform loose, saturated, granular soil to a liquid state (liquefaction), with a loss in the ability to support loads resulting in settlement. Seismically induced settlement of unsaturated sediments, known as dynamic settlement, can also occur. Soil types most susceptible to dynamic settlement are similar to those prone to liquefaction.
The most significant BAS document for liquefaction hazards in the city of Edgewood is the *Liquefaction Susceptibility Map of Pierce County* by Palmer et al. (2004). This map and the accompanying report, titled *Liquefaction Susceptibility and Site Class Maps of Washington State, By County* were prepared by the Washington Department of Natural Resources (DNR) to describe the location and extent of earthquake hazards in Washington. One of the stated purposes of the report was to allow local jurisdictions “to delineate earthquake hazardous areas and enforce Critical Areas ordinances as required by the State Growth Management Act.” The report also states that “local building officials will be able to use these maps to help delineate areas requiring thorough geotechnical investigation in their enforcement of state and local building codes.”

Review of the *Liquefaction Susceptibility Map of Pierce County* indicates that within the Edgewood area, areas most susceptible to liquefaction include those portion of the city that extend into the valley floors of the White and Puyallup Rivers. These areas are underlain by loose, post-glacial alluvial deposits accompanied by a relatively shallow ground water level.

**Tsunami Hazards**

The most current source of information regarding tsunami hazards in the Edgewood area is the *Tsunami Hazard Map of Tacoma, Washington* by Walsh et al., 2009.

**Ground Motion**

Another important source of information for seismic data in the city of Edgewood is the U.S. Geological Survey Earthquake Hazards Program website (https://earthquake.usgs.gov/designmaps/us/application.php). This source of information provides seismic design maps for the entire U.S., including probabilities of earthquake ground motions which are used to provide design values for the seismic provisions of building codes, risk assessment, and public policy.

The following engineering manuals are periodically updated to address potential ground motions for design of buildings and other structures. The methodologies for obtaining engineering design values based on the current USGS probabilistic and deterministic ground motion parameters for designing structures.

- 2015 Minimum Design Loads for Buildings and Other Structures, ASCE 7-16 (“2016 ASCE-7 Standard”) (ASCE, 2016); and,

These three manuals represent the BAS for seismic design of structures.
Review of Existing Regulations

The following is a description of suggested changes, organized by category within the code. Some of the suggested changes presented below are discussed in general terms and may not refer to specific code citations. For a more detailed description of the suggested changes, please refer to the Gap Analysis Matrix.

Seismic Hazard Mapping

We recommend that references in the code to the Critical Areas Atlas or to the DNR Liquefaction and Dynamic Settlement Hazard Table be replaced by a reference to the new Geologically Hazardous Areas map. The Liquefaction and/or Dynamic Settlement Hazard Area to be included on the new map should be based on the previously referenced Liquefaction Susceptibility Map of Pierce County.

Tsunami and Seiche Hazards

We recommend that EMC 14.90.020(B)(4) and any other references in the code to tsunami and seiche hazards be removed. Review of the Tsunami Hazard Map of Tacoma, Washington by Walsh et al., 2009 indicates that projected tsunami inundation associated with seismic events on the Seattle and Tacoma Faults does not extend into the Edgewood city limits. Based on correspondence with Timothy Walsh, assistant State geologist with Washington DNR, we also understand that inundation models for CSZ seismic events also indicate that tsunami inundation would not extend into the city of Edgewood (Walsh, pers. Comm, June 8, 2017).

A seiche is a temporary disturbance or oscillation in the water level of a lake or partially enclosed body of water in response to seismic activity. Given the lack of large surface water bodies in the city of Edgewood, it is our opinion that the risk of damage resulting from a seiche in the city of Edgewood is low.

Gas Pipelines

EMC 14.90.040(B)(2) prohibits the use of gas pipelines in Liquefaction and Dynamic Settlement Hazard Areas. We recommend that this be reviewed by a mechanical engineer to confirm if this is necessary.

Reporting

Minimum reporting requirements are specified in Sections 14.90.030(B) and 14.90.060 of the code. The following revisions are intended to revise the reporting requirements to be consistent with typical standard of practice and BAS as discussed below.

- The existing code describes three types of geological assessment reports. In order of increasing complexity, these include Geotechnical Letter, Geotechnical Verification, and Geotechnical Report. The code specifies the conditions in which each of these three types of reports are required. In general, the complexity of the required report is based on the proximity of the site (or project area within a site) to a Liquefaction or Dynamic Settlement Hazard Area as determined by the geotechnical professional. We recommend that the Geotechnical Letter be removed from the code and replaced with the Geotechnical Verification as the minimum reporting standard. In our opinion, the Geotechnical Verification presents a reasonable minimum standard of reporting and elimination of the Geotechnical Letter provides some simplification of the code.
• We recommend that EMC 14.90.030(B)(5) be revised to require that geologic assessments be stamped by the geotechnical professional. This requirement is consistent with the standard of practice and eliminates the need for the compulsory statement of qualifications paragraph in EMC 14.90.060, Appendix A, Article I, (A)(3) and other similar compulsory paragraphs.

• We recommend that the requirement for the first page of the document to be titled “Liquefaction or Dynamic Settlement Hazard Verification” or “Liquefaction or Dynamic Settlement Hazard Geotechnical Report” be removed. Typically the contents of either of these documents would be conducted as part of an overall geotechnical engineering report that would address other geotechnical aspects of the project, such as design values and other geologic hazards. Therefore, the report title as required under the existing code would not be appropriate given the scope of the report content.

• We recommend that the requirement for a topographic survey with 2-foot contours be removed from the code because topography is not typically relevant to liquefaction or dynamic settlement hazards.

• We recommend that the requirement to include a site plan with the locations of the proposed clearing limits, structures and other improvements be eliminated. It is common for geotechnical studies to be conducted early in the design phase of the project when the locations of proposed features are conceptual, unknown, or dependent on the findings of the geotechnical study.

• We recommend that EMC 14.90.060, Appendix A, Article III(A)(3)(b) be revised to eliminate the requirement to provide mitigation options resulting in a range of structural damage. Depending on the project and site conditions, evaluation of a range of options may not be necessary. Also, geotechnical evaluations of liquefaction or dynamic settlement hazards are typically limited to an evaluation of anticipated seismically induced settlement. Determination of how the predicted settlement translates into structural damage lies outside of the field of geotechnical engineering/engineering geology.

• We recommend that the code be revised to eliminate the requirement for all site plans to be drawn to specific scales. As long as the site plan is drawn to scale, the geotechnical professional should be able to use their own discretion to determine the scale of the drawing. Setting mandatory scale sizes in the code could result in excessively large plans or other undesirable results.

• We recommend that the requirement for the geotechnical professional to provide a recommendation for a setback from Liquefaction and/or Dynamic Settlement Hazard Areas should be deleted from the code. Typically mitigation of these hazards is accomplished through the use of deep or modified foundations, or ground improvement techniques, not setbacks.

• We recommend that EMC 14.90.060, Appendix A, Article III(A)(5) be revised to exclude specification of the type of field exploration to be conducted. In our opinion, revision of this section of the code to read: “The geotechnical study shall include field exploration sufficient to assess the potential for liquefaction or dynamic settlement hazards and options for mitigation of those hazards. Copies of the exploration logs shall be included in the report. The project geotechnical professional must provide justification for the scope of the field exploration program. The City’s geotechnical
professional reserves the right to request additional exploration if deemed appropriate. If a dispute arises between the City’s geotechnical professional and the project geotechnical professional regarding the scope of the field exploration, the City reserves the right to require an independent, third party review to be paid for by the applicant to resolve the dispute.” This modification retains the requirement for subsurface exploration, but leaves the type of exploration, and other details (such as the exploration log format) up to the discretion of the geotechnical professional. It also includes provisions to require additional field exploration, if necessary, if the scope of the field exploration conducted falls short of the normal standard of practice as determined through independent third party review.

- We recommend that EMC 14.90.060, Appendix A, Article III(A)(7) be modified to require use of ground motion parameters equivalent to the most current version of the International Building Code (IBC).

- We recommend that EMC 14.90.060, Appendix A, Article III(A)(9) be modified to eliminate the reference to Youd and Idriss (1997). This reference is out of date and research in this area is on-going. The proposed revision leaves the methodology of analysis open to “state-of-the-practice methodologies.”

- EMC 14.90.060, Appendix A, Article III(A)(10) specifies that the geotechnical report shall include an assessment of a wide variety of failure mechanisms. Some of these failure mechanisms, such as settlement, are applicable to all liquefaction-prone sites, but others, such as lateral spreading or flotation of buried facilities, are uncommon or not applicable to areas within the city. For this reason, we recommend that this section be prefaced with ”When appropriate,”. The revised wording is intended to limit the need for analysis to hazards of concern.

- EMC 14.90.060, Appendix A, Article III(A)(11) specifies minimum reporting requirements regarding mitigation of seismic hazards, including mitigation options, inclusion of final design, plans, and specifications if applicable, performance standards and verification testing requirements for ground improvement. Because geotechnical reports typically include geotechnical design recommendations, but not actual plans and specifications (which are usually prepared by others), we recommend that this section of the code also include a statement specifying that geotechnical review of all design plans is required and shall be documented in writing.

- We recommend that EMC 14.90.060, Appendix B, Item (A)(3)(d)(ii) be modified to include review of LiDAR mapping.

EROSION HAZARDS

Soil erosion is defined as the wearing away of the earth’s surface as a result of the movement of wind, water, or ice (Pierce County, 2015). Factors influencing erosion potential include soil characteristics, vegetative cover, topography, and climate (Washington State Department of Ecology [Ecology], 2014). Water is typically the primary agent contributing to erosion in Western Washington. Sedimentation is defined as the gravity-induced settling of soil particles transported by water (Ecology, 2014). In order to mitigate impacts associated with erosion and sedimentation, Temporary Erosion and Sedimentation Control (TESC) plans are generally
required by municipalities for grading activities. In addition, seasonal grading restrictions are also commonly
implemented to reduce the risk of erosion hazards during the wet season (typically between October 31st and April 1st).

**Erosion Hazard Impacts**

Potential impacts of erosion and sedimentation include (Ecology, 2014):

1. Natural, nutrient-rich topsoils erode. Re-establishing vegetation is difficult without applying soil amendments and fertilizers.

2. Silt fills culverts and storm drains, decreasing capacities and increasing flooding and maintenance frequency.

3. Detention facilities fill rapidly with sediment, decreasing storage capacity and increasing flooding.


5. Sediment causes obstructions in streams and harbors, requiring dredging to restore navigability.

6. Shallow areas in lakes form rapidly, resulting in growth of aquatic plants and reduced usability.

7. Nutrient loading from phosphorus and nitrogen attached to soil particles and transported to lakes and streams cause a change in the water pH, algal blooms, and oxygen depletion, leading to eutrophication and fish kills.

8. Water treatment for domestic uses becomes more difficult and costly.

9. Turbid water replaces aesthetically pleasing, clear, clean water in streams and lakes.

10. Eroded soil particles decrease the viability of macro-invertebrates and food-chain organisms, impair the feeding ability of aquatic animals, clog gill passages of fish, and reduce photosynthesis.

11. Sediment-clogged gravel diminishes fish spawning and can smother eggs or young fry.

**Erosion Hazard Mapping**

The U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) has mapped soils throughout Pierce County and provides erosion hazard ratings for each of the mapped soil types. The predecessor of the NRCS, known as the Soil Conservation Service, published the Soil Survey for Pierce County in 1979. Updated soil survey data is now available online through the NRCS through their Web Soil Survey [https://websoilsurvey.nrcs.usda.gov/app/](https://websoilsurvey.nrcs.usda.gov/app/). This is the best source of information for soil erosion hazards in Pierce County and represents BAS.
Erosion and Sedimentation Control

Regulatory protection for Erosion Hazard Areas in Western Washington typically include the following:


- Implementation of permitting requirements through the Construction Storm Water General Permit (also known as the National Pollutant Discharge Elimination System [NPDES] permit).

- Required TESC monitoring by a Certified Erosion and Sediment Control Lead (CESCL) for the duration of the construction.

- Vegetation management.

- Seasonal clearing and grading restrictions.

Best Management Practices (BMPs) for erosion and sedimentation control for each of the 13 essential elements of a SWPPP are defined in the 2014 Ecology Manual and represent BAS.

Review of Existing Regulations

The following is a description of suggested changes, organized by category within the code. Some of the suggested changes presented below are discussed in general terms and may not refer to specific code citations. For a more detailed description of the suggested changes, please refer to the Gap Analysis Matrix.

Erosion Hazard Indicators, Categories, and Review Procedures

Erosion hazard indicators and categories are defined in EMC 110.020 and EMC 110.030. The following changes are intended to revise this section of the code to be consistent with typical standard of practice and BAS.

- EMC 14.110.020(A)(1) refers to areas of active bluff retreat. In the Puget Lowland, the term “bluff” is normally used to refer to describe a steep slope or cliff along a marine shoreline area. Because no marine shoreline areas exist in the city of Edgewood, we recommend that this section be removed from the code. Other references in the code to marine shorelines should also be removed, such as those in EMC 14.110.020(A)(2), EMC 14.110.030(B)(3), and EMC 14.110.030(B)(6).

- We recommend that all references in the code to the Critical Areas Atlas be replaced with a reference to the new Geologically Hazardous Areas map. For ease of use, we also recommend that this map be made available on line. The Geologically Hazardous Areas map should be revised to include Erosion Hazard Areas and Potential Erosion Hazard Areas as defined in EMC 14.110.020.

- We recommend that EMC 110.030(B)(2) be revised to include review of LiDAR-based mapping.
**Buffer Widths**

We recommend that EMC 110.050(A)(2) be revised to allow reduction or elimination of the shoreline buffer widths specified in EMC 110.050(A)(2)(a) and EMC 110.050(A)(2)(b) upon approval by the Department of a geotechnical report that demonstrates that such a reduction would not result in an increased risk of erosion either on or off of the subject property. This modification to the code would open the possibility of reducing or eliminating the buffer if it can be justified by site conditions and BAS.

**Reporting**

Minimum reporting requirements are specified in Sections 14.110.060 of the code. The following revisions are intended to revise the reporting requirements to be consistent with typical standard of practice and BAS as discussed below.

- We recommend that the requirement for the first page of the document to be titled “Shoreline Erosion Hazard Letter,” “Shoreline Erosion Hazard Verification,” or “Shoreline Erosion Hazard Report” be removed. Typically the contents of any of these documents would be conducted as part of an overall geotechnical engineering report that would address other geotechnical aspects of the project, such as design values and other geologic hazards. Therefore, the report title as required under the existing code would not be appropriate given the scope of the report content.

- We recommend that EMC 14.110.060, Appendix A, Item 5, EMC 14.110.060, Appendix B, Item 6, and EMC 14.110.060, Appendix C, Item 6 be revised to include a statement that the document will include a summary of the findings of the site visit, a site plan, and a summary of the findings from review of the documents listed in EMC 14.110.030(B)(2). This requirement would verify compliance with the minimum assessment requirements per 14.110.030(B)(2).

- We recommend that EMC 14.110.060, Appendix A, Item 6, EMC 14.110.060, Appendix B, Item 8, and EMC 14.110.060, Appendix C, Item 8 be removed from the code. These sections of the code consist of a statement of qualification. By definition, a licensed geotechnical professional is qualified. If the report is signed and stamped by a geotechnical professional as required under EMC 14.110.030(B)(4), the intent of this paragraph is satisfied. The latter part of this paragraph, which consists of a statement verifying that the scope of the investigation is sufficient, is unnecessary. It is the intent of any study to meet this standard and if the scope of the investigation is not met, whether by incompetency or oversight, the City has the right to respond with review comments.
REFERENCES CITED

American Society of Civil Engineers (ASCE), 2016, Minimum design loads for buildings and other structures, ASCE 7-16.


Bonney Lake Municipal Code, Chapter 16.28.010.


GeoMapNW, 2004, Draft geologic map of the Puyallup quadrangle, Washington.


National Earthquake Hazards Reduction Program (NEHRP), 2015, Recommended seismic provisions for new buildings and other structures: FEMA P-1050.


Pierce County Surface Water Management (Pierce County), 2015, Pierce County stormwater management and site development manual.

Puget Sound LiDAR Consortium.

Snohomish County Code, Chapter 30.62B.340.

Sumner Municipal Code, Chapter 16.50.050.


Walsh, T., Assistant State Geologist, Washington Department of Natural Resources, personal communication, June 8, 2017.


Washington State Department of Natural Resources, Undated.